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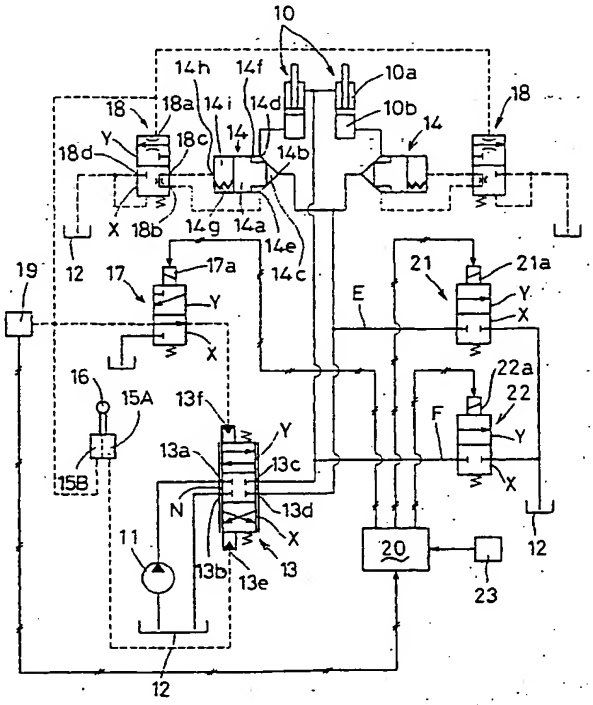
(54) BOOM CYLINDER CONTROL CIRCUIT OF WORKING MACHINE

(57) The invention provides a boom cylinder control circuit of a working machine which makes boom operations easy when stone crushing operations by means of a breaker or operations to move a bucket back and forth along the ground are performed, wherein a control circuit of a boom cylinder 10 is provided with a lowering side oil discharging passage E and a rising side oil discharging passage F which allow oil of an oil chamber on the head side 10b and an oil chamber on the rod side 10a of the boom cylinder to flow toward an oil reservoir 12 without passing through a control valve 13 and a second solenoid vale 21 and a third solenoid valve 22 which act to open and close these oil discharging passages, respectively.

Fig. 2



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Description

Technical Field

[0001] The present invention belongs to the technical field of a boom cylinder control circuit of an operation machine such as a hydraulic shovel.

Background Art

[0002] In general, as operation machines such as hydraulic shovels and the like, there is one wherein a stick is supported so as to be swingable back and forth on the front end portion of a boom whose base end portion is supported so as to be swingable up and down on the machine main body and a tool such as a bucket, a breaker, a clamshell or the like is attached on the front end portion of the said stick. In such a working machine, for example as shown in Fig. 5, when removing operations of rocks lying on flat ground are performed by moving a bucket 7 back and forth along the ground, in addition to manipulations of the stick 6, manipulations of a boom 5 are performed simultaneously in order to move the boom up and down. Also, as shown in Fig. 6, when rock crushing operations are performed by means of a breaker 8, it is necessary to manipulate the boom 5 toward the lowering side and press the breaker 8 against rocks, and perform the operations so as to always apply an appropriate thrust to the breaker 8. In addition, when operations to scoop up objects are operated by means of a clamshell, the boom is lowered until the clamshell makes contact with the objects.

[0003] However, in the aforementioned operations to move the bucket in the back and forth direction along the ground, if the stick operations and the boom operations are not performed simultaneously and appropriately, the bucket front end bites into the ground or lifts off the ground and work efficiency lowers. Also, in the breaker operations, if a force to press the boom downward is too great, the machine body is lifted and operations cannot be easily performed, and if a force to press the boom downward is too small, a necessary thrust cannot be obtained, therefore finding the proper balance thereof is difficult. Furthermore, in the operations using the clamshell, it is necessary to stop the boom lowering operation upon recognition that the clamshell makes contact with the object to be scooped up. Therefore, during these operations, close attention must be paid to boom manipulations at all times, manipulations are complicated and an operator's fatigue increases. In addition, with the boom operations, pressure oil is supplied to the boom cylinder, therefore fuel consumption increases and fuel efficiency is poor. Herein there are problems to be solved by the present invention.

Disclosure of the Invention

[0004] In view of the above-described circumstances, the present invention has been created with the aim of solving these problems and provides a working machine comprising a boom cylinder for moving a boom up and down, wherein a control circuit of the boom cylinder is provided with: a control valve which performs pressure oil supplying and discharging control with respect to the boom cylinder based on manipulations of an operating member; a lowering side oil discharging passage which allows oil of a boom cylinder head side oil chamber to flow toward the oil reservoir side without passing through the control valve; and a control means which performs opening and closing control of the said lowering side oil discharging passage.

[0005] By constructing as such, when the lower side oil discharging passage is opened, discharge of oil from the head side oil chamber of the boom cylinder is allowed and the boom moves down due to the empty weight. For example, when stone crushing operations are performed by means of the breaker, boom operations become easy and fuel consumption can be reduced.

[0006] Herein, the control circuit of the boom cylinder is further provided with: a rising side oil discharging passage which allows oil of a boom cylinder rod side oil chamber to flow toward the oil reservoir side without passing through the control valve and a control means for performing opening and closing control of the rising side oil discharging passage, whereby when the lowering and rising side oil discharging passages are opened, discharges of oil from the boom cylinder head side and rod side oil chambers are allowed and the boom moves down due to the empty weight and moves up due to an external force. For example, operations to move the bucket in the back and forth direction along the ground are performed, boom operations become easy and fuel consumption can be reduced.

[0007] Also, herein, the lowering side oil discharging passage is controlled so as to be opened based on a manipulation of the operating member toward the boom lowering side and on the other hand, when the said lowering side oil discharging passage is open, the lowering side oil discharging passage is controlled so that, even by operating the operating member toward the boom lowering side, the pressure oil is not supplied from the control valve to the boom cylinder, whereby it is avoidable that the boom unexpectedly moves down due to the empty weight without an operator's intentions.

[0008] Also herein, the control means which performs opening and closing control of the lowering side oil discharging passage and the rising side oil discharging passage can comprise solenoid valves which can be switched between the opening position to open the oil discharging passage and closing position to close the oil discharging passage.

[0009] Furthermore, the present invention can be carried out in a control circuit of the boom cylinder which is provided with: valves for preventing empty weight-lowering which, when the operating member is not manip-

ulated toward the boom lowering side, prevent oil from being discharged from the boom cylinder head side oil chamber, but, based on a manipulation toward the boom lowering side, allow oil to be discharged from the head side oil chamber.

Brief Description of Drawings

[0010]

Fig. 1 is a side view of the hydraulic shovel.
Fig. 2 is a hydraulic circuit diagram of the boom cylinder.
Fig. 3 is a hydraulic circuit diagram of the boom cylinder when a manipulation toward the boom lowering side is performed in a condition where a "lowering hold releasing mode" is set.
Fig. 4 is a hydraulic circuit diagram of the boom cylinder when a manipulation toward the boom lowering side is performed in a condition where a "lowering and rising hold releasing mode" is set.
Fig. 5 is a view showing rock removing operations on flat ground by a bucket.
Fig. 6 is a view showing stone crushing operations by a breaker.

Best Mode for Carrying out the Invention

[0011] Now, an embodiment of the invention will be described with reference to the drawings. In the drawings, 1 denotes a hydraulic shovel and the basic construction is the same as that of the prior art such that the said hydraulic shovel 1 comprises various portions such as a crawler-type lower structure 2, an upper structure 3 which is rotatably supported on the said lower structure 2, a front attachment 4 mounted on the said upper structure 3 and the like, and furthermore, the said front attachment 4 comprises various members such as a boom 5 which is supported so as to be swingable up and down on the upper structure 3, a stick 6 which is supported so as to be swingable back and forth on the front end portion of the boom 5, a bucket 7 which is attached so as to be swingable back and forth on the front end portion of the stick 6 and the like.

[0012] Instead of the bucket 7, a variety of tools such as a breaker 8, a clamshell (not illustrated) and the like can be attached on the front end portion of the stick 6 depending on the operations performed by the hydraulic shovel 1.

[0013] 10 denotes a boom cylinder to swing the boom 5 up and down and a pressure oil charging and discharging circuit of the said boom cylinder 10 is shown in Fig. 2. In Fig. 2, 11 denotes a hydraulic pump, 12 denotes an oil reservoir, 13 is a control valve for the boom, and the control valve 13 comprises a 3-position selector valve provided with a first port 13a to be connected to the hydraulic pump 11, a second port 13b to be connected to the oil reservoir 12, a third port 13c to be connected to an oil chamber 10a on the rod side (cylinder contracting side) of the boom cylinder 10, a fourth port 13d to be connected to an oil chamber 10b on the head side (cylinder expanding side) of the boom cylinder 10 via a logic valve 14 (which will be described later), and pilot ports 13e and 13f on the expanding side and contracting side.

[0014] Then, in a condition where a pilot pressure is not supplied to either of the pilot ports 13e and 13f, the control valve 13 is located at a neutral position N where the first through fourth ports 13a through 13d are closed, however, when a pilot pressure is supplied to the expanding side pilot port 13e, the control valve 13 is switched to an expanding side position X where the valve passage from the first port 13a to the fourth port 13d and the valve passage from the third port 13c to the second port 13b are opened and pressure oil from the hydraulic pump 11 is supplied to the head side oil chamber 10b of the boom cylinder 10 via the logic valve 14, while oil discharged from the rod side oil chamber 10a is flowed toward the oil reservoir 12. In addition, when a pilot pressure is supplied to the contracting side pilot port 13f, the control valve 13 is switched to a contracting side position Y where the valve passage from the first port 13a to the third port 13c and the valve passage from the fourth port 13d to the second port 13b are opened and pressure oil from the hydraulic pump 11 is supplied to the rod side oil chamber 10a of the boom cylinder 10, while oil discharged from the head side oil chamber 10b is flowed toward the oil reservoir 12 via the logic valve 14.

[0015] 15A and 15B denote pilot valves on the expanding side and contracting side, and by manipulating a boom operating lever 16 toward the boom rising side (cylinder expanding side) or the boom lowering side (cylinder contracting side), a pilot pressure is output from the pilot valve 15A or 15B on the side thus operated.

[0016] Then, the pilot pressure output from the expanding side pilot valve 15A is supplied to the expanding side pilot port 13e of the control valve 13. In addition, the pilot pressure output from the contracting side pilot valve 15B is supplied to the contracting side pilot port 13f of the control valve 13 via a first solenoid valve 17 (which will be described later) and also supplied to a pilot port 18a of a control valve 18 (which will be described later). Furthermore, when the pilot pressure is outputted from the contracting side pilot valve 15B, the said pressure is detected by a pressure sensor 19.

[0017] The first solenoid valve 17 is a 2-position selector valve and this is, in a condition where a solenoid 17a is not excited, located at the first position X where the pilot pressure output from the contracting side pilot valve 15B is supplied to the control valve contracting side pilot port 13f, however, when the solenoid 17a is excited based on a command from a control portion 20 (which will be described later), the first solenoid valve 17 is switched to the second position Y where the pilot pressure is not supplied to the control valve contracting

side pilot port 13f.

[0018] The control valve 18 is a 2-position selector valve provided with the pilot port 18a and the first through third ports 18b through 18d. As mentioned before, the pilot port 18a is connected to the contracting side pilot valve 15B, the first port 18b is connected to a first pilot port 14e of the logic valve 14 (which will be described later), the second port 18c is connected to a second pilot port 14h of the logic valve 14, and the third port 18d is connected to the oil reservoir 12.

[0019] Then, the control valve 18 is located at a first position X where the valve passage which communicates the first port 18b to the second port 18c is opened and the third port 18d is closed when a pilot pressure is not supplied to the pilot port 18a, however, when a pilot pressure is supplied to the pilot port 18a, the control valve 18 is switched to a second position Y where the first port 18b is closed and the valve passage from the second port 18c to the third port 18d is opened.

[0020] On the other hand, the logic valve 14 is constructed using a poppet 14a and provided with a first oil chamber 14c where a first port 14b is formed, a second oil chamber 14f where a second port 14d and the first pilot port 14e are formed, and a spring storage chamber 14i where a spring 14g is stored and the second pilot port 14h is formed.

[0021] The first port 14b of the logic valve 14 is connected to the fourth port 13d of the control valve 13, the second port 14d is connected to the head side oil chamber 10b of the boom cylinder 10, the first pilot port 14e is, as mentioned before, connected to the first port 18b of the control valve 18, and the second pilot port 14h is connected to the second port 18c of the control valve 18. Also, the spring 14g is set so as to press the poppet 14a toward the closing position side (which will be described later).

[0022] The logic valve 14 is structured so that, in a condition where the control valve 18 is located at the first position X, the pressure of the head side oil chamber 10b of the boom cylinder 10 is introduced in the spring storage chamber 14i via the second port 14d, the second oil chamber 14f, the first pilot port 14e, the control valve 18 at the first position X, and the second pilot port 14h, and the pressure introduced in the said spring storage chamber 14i acts as a force to press the poppet 14a toward the closing position side. On the other hand, in a condition where the control valve 18 is located at the second position Y, the pressure of the boom cylinder head oil chamber 10b is not introduced in the spring storage chamber 14i and the oil of the spring storage chamber 14i is flowed toward the oil reservoir 12 via the control valve 18 at the second position Y.

[0023] The poppet 14a is structured so as to be movable to the closing position (the position of the poppet 14a of Fig. 2) where the valve passage 14k which communicates the first oil chamber 14c to the second oil chamber 14f is closed to prevent oil from entering or exiting from the boom cylinder head side oil chamber 10b and the opening position (the position of the poppet 14a of Figs. 3 and 4.) where the valve passage 14k is opened and allows oil to enter or exit from the boom cylinder head side oil chamber 10b. Herein, as mentioned before, the pressure introduced in the spring storage chamber 14i and a pressing force of the spring 14g are set so as to act as a force to press the poppet 14a toward the closing position side and the pressure inputted in the first oil chamber 14c and the second oil chamber 14f is set so as to act as a force to press the poppet 14a toward the opening position side.

[0024] In the condition where the control valve 18 is located at the first position X, the poppet 14a is pressed by the total pressure (A + B) of the pressure A introduced in the spring storage chamber 14i and the pressing force B of the spring 14g toward the closing position side. The above-described total pressure (A + B) is set so as to be greater than the pressure C which is inputted from the boom cylinder head side oil chamber 10b into the second oil chamber 14f and presses the poppet 14a toward the opening position side (A + B > C) but smaller than the total pressure (C + D) of the said pressure C and the pressure D which is inputted from the hydraulic pump 11 via the control valve 13 at the expanding side position X into the first oil chamber 14c and presses the poppet 14a toward the opening position side (A + B < C + D). Thus, in the condition where the control valve 18 is located at the first position X, that is, when the boom operating lever 16 is not manipulated toward the boom lowering side, the poppet 14a is held at the closing position and prevents oil from being discharged from the boom cylinder head side oil chamber 10b as long as the pressure oil from the hydraulic pump 11 is not inputted into the first oil chamber 14c. On the other hand, when the boom operating lever 16 is manipulated toward the boom rising side, the pressure oil from the hydraulic pump 11 is inputted into the first oil chamber 14c, and the poppet 14a is located at the opening position.

[0025] In addition, in the condition where the control valve 18 is located at the second position Y, the poppet 14a is pressed toward the closing position side only by the pressing force B of the spring 14g, while the said pressing force B of the spring 14g is set so as to be smaller than the pressure C which is inputted from the boom cylinder head side oil chamber 10b into the second oil chamber 14f and presses the poppet 14a toward the opening position side (B < C). Thus, in the condition where the control valve 18 is located at the second position Y, that is, when the boom operating lever 16 is manipulated toward the boom lowering side, the poppet 14a is located at the opening position by the pressure of the boom cylinder head side oil chamber 10b.

[0026] Namely, when the boom operating lever 16 is manipulated toward the lowering side or the rising side, the logic valve 14 is located at the opening side and allows oil to enter and exit from the boom cylinder head side oil chamber 10b, whereas when the boom operating lever 16 is not manipulated toward either the lower-

ing side or the rising side, the logic valve 14 is held at the closing side and prevents oil from being discharged from the boom cylinder head side oil chamber 10b. Thus, for example, even when an incident such as a leakage occurs in a pipe from the control valve 13 to the boom cylinder 10, the boom 5 is prevented from lowering due to the empty weight of the front attachment 4. Herein, the logic valve 14 and the control valve 18 are directly mounted on the boom cylinder 10 as one valve unit for preventing empty weight-lowering.

[0027] On the other hand, a lowering side oil discharging passage E leading to the oil reservoir 12 is formed by branching off from the oil passage which couples the control valve fourth port 13d with the logic valve first port 14b. A second solenoid valve 21 (which will be described later) is disposed on the said lowering side oil passage E. Also, a rising side oil discharging passage F leading to the oil reservoir 12 is formed by branching off from the oil passage which couples the control valve third port 13c with the boom cylinder rod side oil chamber 10a. A third solenoid valve 22 (which will be described later) is disposed on the said rising side discharging oil passage F.

[0028] The second solenoid valve 21 and the third solenoid valve 22 are 2-position selector valves and these are, in a condition where solenoids 21a and 22a are not excited, located at the closing position X where the lowering side discharging oil passage E and the rising side discharging oil passage F are respectively closed, however, when the solenoids 21a and 22a are excited based on commands from a control unit 20, the second solenoid valve 21 and the third solenoid valve 22 are switched to the opening position Y where the lowering side discharging oil passage E and the rising side discharging oil passage F are respectively opened. Then, in the condition where the second solenoid valve 21 is located at the opening position Y, the oil discharged from the boom cylinder head side oil chamber 10b via the logic valve 14 at the opening side can be flowed to the oil reservoir 12 via the lowering side oil discharging passage E, and in the condition where the third solenoid valve 22 is located at the opening position Y, the oil discharged from the boom cylinder rod side oil chamber 10a can be flowed to the oil reservoir 12 via the rising side oil discharging passage F.

[0029] On the other hand, the control unit 20 is constructed using a microcomputer and the like, wherein signals from the pressure sensor 19 and a mode selector switch 23 (which will be described later) are inputted and based on the said input signal, solenoid exciting control signals are outputted to the first through third solenoid valves 17, 21, and 22.

[0030] The mode selector switch 23 is provided on the operator's seat portion of the hydraulic shovel 1 and can select and set from three modes of "normal mode" for performing normal operations such as excavation and loading and the like, "lowering hold releasing mode" for performing operations to crush stones and the like by means of the breaker 8, and "lowering and rising hold releasing mode" for performing operations to move the bucket 7 back and forth along the ground and the like.

[0031] When the mode selector switch 23 is set to the "normal mode", the control unit 20 does not output the solenoid exiting signals to the first, second, and third solenoid valves 17, 21, and 22. Accordingly, the first solenoid valve 17 is located at the first position X where the pilot pressure output from the contracting side pilot port 15B is supplied to the control valve contracting side pilot port 13f. Also, the second solenoid valve 21 and the third solenoid valve 22 are located at the closing position X where the lowering side oil discharging passage E and the rising side oil discharging passage F are respectively closed.

[0032] In the "normal mode", when the boom operating lever 16 is not manipulated toward either rising side or lowering side, a pilot pressure is not output from either of the pilot valves 15A and 15B on the expanding side and the contracting side, the control valve 13 is located at the neutral position N, and the control valve 18 is located at the first position X. In this condition, the boom cylinder 10 is halted, and in addition, since the oil discharging passages from the rod side oil chamber 10a and head side oil chamber 10b of the boom cylinder 10 to the oil reservoir 12 are closed by the third and second solenoid valves 22 and 21 at the closing position Y and the control valve 13 at the neutral position N, oil is not discharged from either of the oil chambers 10a and 10b, thus even when an external force toward the lowering side or the rising side is applied to the boom 5, the boom cylinder 10 does not contract.

[0033] On the other hand, in the "normal mode", when the boom operating lever 16 is manipulated toward the rising side, the control valve 13 is switched to the expanding side position X due to the pilot pressure output from the expanding side pilot valve 15A. Accordingly, the pressure oil output from the hydraulic pump 11 is supplied via the logic valve 14 at the opening position to the boom cylinder head side oil chamber 10b. Also, the oil of the boom cylinder road side oil chamber 10a is discharged via the control valve 13 at the expanding side position X to the oil reservoir 12, thus the boom cylinder 10 expands and the boom 5 moves up.

[0034] In the "normal mode", when the boom operating lever 16 is manipulated toward the lowering side, a pilot pressure is output from the contracting side pilot valve 15B. The said pilot pressure is supplied via the first solenoid valve 17 at the first position X to the control valve contracting side pilot port 13f and switches the control valve 13 to the contracting side position Y, while the said pilot pressure is supplied to the pilot port 18a of the control valve 18 and switches the control valve 18 to the second position Y. Accordingly, the pressure oil output from the hydraulic pump 11 is supplied via the control valve 13 at the contracting side position Y to the boom cylinder rod side oil chamber 10a. Also, the oil of the boom cylinder head side oil chamber 10b is dis-

charged via the logic valve 14 at the opening position and the control valve 13 at the contracting side position Y to the oil reservoir 12, thus the boom cylinder 10 contracts and the boom 5 moves down.

[0035] On the other hand, when the mode selector switch 23 is set to the "lowering hold releasing mode", the control unit 20 outputs the solenoid exciting signal to the first solenoid valve 17. Accordingly, the first solenoid valve 17 is switched to the second position Y where the pilot pressure output from the contracting side pilot valve 15B is not supplied to the control valve contracting side pilot port 13f. When the output of the pilot pressure from the contracting side pilot valve 15B is detected by the pressure sensor 19, the control unit 20 further outputs a solenoid exciting signal to the second solenoid valve 21, whereby the second solenoid valve 21 is switched to the opening side Y where the lowering side oil discharging passage E is opened. On the other hand, when a solenoid exciting signal is not outputted to the third solenoid valve 22, the said third solenoid valve 22 is held at the closing position X where the rising side oil discharging passage F is closed.

[0036] In the "lowering hold releasing mode", when the boom operating lever 16 is not manipulated toward either rising side or lowering side, the control valve 13 is located at the neutral position N, and the control valve 18 is located at the first position X. In this condition, similar to the aforementioned "normal mode", the boom cylinder 10 is halted, and even when an external force toward the lowering side or the rising side is applied to the boom 5, the boom cylinder 10 never contracts.

[0037] In addition, in the "lowering hold releasing mode", when the boom operating lever 16 is manipulated toward the rising side, similar to the aforementioned "normal mode", the pressure oil of the hydraulic pump 11 is supplied via the control valve 13 at the expanding side position X and the logic valve 14 at the opening position to the boom cylinder head side oil chamber 10b. In this case, since the output of the pilot pressure is not detected by the pressure sensor 19, the second solenoid valve 21 is positioned at the opening side X where the lowering side oil discharging passage E is closed, therefore the pressure oil of the hydraulic pump 11 is not discharged to the oil reservoir 12 via the lowering side oil discharging passage E. On the other hand, the oil of the boom cylinder rod side oil chamber 10a is discharged to the oil reservoir 12 via the control valve 13 at the expanding side X, thus the boom cylinder 10 expands and the boom 5 moves up.

[0038] Furthermore, in the "lowering hold releasing mode", when the boom operating lever 16 is manipulated toward the lowering side, a pilot pressure is output from the contracting side pilot valve 15B, however, since the first solenoid valve 17 is located at the second position Y, the said pilot pressure is not supplied to the control valve contracting side pilot port 13f and the control valve 13 is held at the neutral position N. On the other hand, a pilot pressure output from the contracting side pilot valve 15B is supplied to the pilot port 18a of the control valve 18 and switches the control valve 18 to the second position Y, and based on the detection of the output of the said pilot pressure by the pressure sensor 19, a solenoid exciting signal is output to the second solenoid valve 21 from the control portion 20, whereby the second solenoid valve 21 is switched to the opening position Y where the lowering side oil discharging passage E is opened.

[0039] Namely, when the boom operating lever 16 is manipulated toward the lowering side in the "lowering hold releasing mode", the control valve 13 is located at the neutral position N and the pressure oil from the hydraulic pump 11 is not supplied to the boom cylinder 10, however, the oil of the boom cylinder head side oil chamber 10b is flowed via the logic valve 14 at the opening position and the second solenoid valve 21 at the opening position Y to the oil reservoir 12. In this condition, the boom 5 lowers due to the empty weight of the front attachment 4 until a tool such as a breaker 8 or the like is brought into contact with an obstruction and the lowering movement is restricted. Also, at this time, even when an external force toward the rising side is applied to the boom 5, the oil discharging passage from the boom cylinder rod side oil chamber 10a to the oil reservoir 12 is closed by the control valve 13 at the neutral position N and the third solenoid valve 22 at the closing position X, therefore oil is not discharged from the boom cylinder rod side oil chamber 10a, thus the boom 5 never moves up due to the external force.

[0040] On the other hand, when the mode selector switch 23 is set to the "lowering and rising hold releasing mode", the control unit 20 outputs the solenoid exciting signals to the first solenoid valve 17 and the third solenoid valve 22. Accordingly, the first solenoid valve 17 is switched to the second position Y where the pilot pressure output from the contracting side pilot valve 15B is not supplied to the control valve contracting side pilot port 13f. The third solenoid valve 22 is switched to the opening position Y where the rising side oil discharging passage F is opened. When the output of the pilot pressure from the contracting side pilot valve 15B is detected by the pressure sensor 19, the control unit 20 further outputs the solenoid exciting signal to the second solenoid valve 21, whereby the second solenoid valve 21 is switched to the opening position Y where the lowering side oil discharging passage E is opened.

[0041] In the "lowering and rising hold releasing mode", when the boom operating lever 16 is not manipulated toward either rising side or lowering side, the control valve 13 is located at the neutral position N, and the control valve 18 is located at the first position X. In this condition, the pressure oil from the hydraulic pump 11 is not supplied to the boom cylinder 10, while the oil from the boom cylinder rod side oil chamber 10a is flowed via the third solenoid valve 22 at the opening position Y to the oil reservoir 12, and when an external force toward the rising side is applied to the boom 5, the boom 5

moves up. On the other hand, since the oil discharging passage of the oil from the boom cylinder head side oil chamber 10b to the oil reservoir 12 is closed by the second solenoid vale 21 at the closing position X and the control valve 13 at the neutral position N, the oil is not discharged from the boom cylinder head side chamber 10b and the boom 5 never lowers due to the empty weight of the front attachment 4.

[0042] In addition, in the "lowering and rising hold releasing mode", when the boom operating lever 16 is manipulated toward the rising side, the pressure oil of the hydraulic pump 11 is supplied via the control valve 13 at the expanding side position X and the logic valve 14 at the opening position to the boom cylinder head side oil chamber 10b. In this case, since the output of the pilot pressure is not detected by the pressure sensor 19, the second solenoid valve 21 is positioned at the closing side X where the lowering side oil discharging passage E is closed, therefore the pressure oil of the hydraulic pump 11 is not discharged to the oil reservoir 12 via the lowering side oil discharging passage E. On the other hand, the oil of the boom cylinder rod side oil chamber 10a is discharged to the oil reservoir 12 via the control valve 13 at the expanding side position X or the third solenoid valve 22 at the opening position Y, thus the boom cylinder 10 expands and the boom 5 moves up.

[0043] Furthermore, in the "lowering and rising hold releasing mode", when the boom operating lever 16 is manipulated toward the lowering side, similar to the aforementioned "lowering hold releasing mode", the control valve 13 is held at the neutral position N, the control valve 18 is switched to the second position Y, and the second solenoid valve 21 is switched to the opening position Y where the lowering side oil discharging passage E is opened.

[0044] Namely, when the boom operating lever 16 is manipulated toward the lowering side in the "lowering and rising hold releasing mode", the pressure oil from the hydraulic pump 11 is not supplied to the boom cylinder 10, while the oil of the boom cylinder head side oil chamber 10b is flowed via the logic valve 14 at the opening position and the second solenoid valve 21 at the opening position Y to the oil reservoir 12, thus, the boom 5 lowers due to the empty weight of the front attachment 4 until a tool such as the breaker 8 or the like is brought into contact with an obstruction and the lowering movement is restricted. Also, at this time, since the oil of the boom cylinder rod side oil chamber 10a is flowed via the third solenoid valve 22 at the opening position Y to the oil reservoir 12, when an external force toward the rising side is applied to the boom 5, the boom 5 moves up.

[0045] In the aforementioned construction, when normal operations such as excavation and loading and the like are performed, the mode selector switch 23 is set to the "normal mode". Accordingly, as mentioned before, a pressure oil is supplied to the boom cylinder 10 based on manipulations of the boom operating lever 16. On the other hand, since both rising side oil discharging passage E and lowering side oil discharge passage F are closed, the boom 5 does not move up and down due to the external force, thus normal up and down movements of the boom 5 can be performed based on the manipulations of the boom operation lever 16.

[0046] When operations to crush stones and the like are performed by means of the breaker 8, the mode selector switch 23 is set to the "lowering hold releasing mode". In this condition, when the boom operating lever 16 is manipulated toward the lowering side, the control valve 13 is held at the neutral position N, while the lowering side oil discharging passage F is opened. The boom 5 moves down due to the empty weight of the front attachment 4. Thus, the breaker 8 is pressed downward by the empty weight of the front attachment 4 and can obtain a thrust that is required in the stone crushing operations. Moreover, at this time, the rising side oil discharging passage E is closed and upward movement is restricted, the reaction force is not lost and effective breaker operations can be performed.

[0047] Furthermore, when operations to remove rocks lying on flat ground are performed by moving the bucket 7 back and forth along the ground, the mode selector switch 23 is set to the "lowering and rising hold releasing mode". In this condition, when the boom operating lever 16 is manipulated toward the lowering side, the control valve 13 is held at the neutral position N, while the rising side oil discharging passage E and the lowering side oil discharging passage F are opened. The boom 5 moves up due to the external force and moves down due to the empty weight of the front attachment 4. Namely, in a condition where the bucket 7 is in contact with the ground, when the stick 6 is moved in the back and forth direction, the boom 5 automatically moves up due to the reaction force that the bucket 7 receives from the ground and also automatically moves down due to the empty weight of the front attachment 4. The bucket 7 can be moved in the back and forth direction along the ground without performing operations to move the boom 5 up and down.

[0048] Furthermore, when operations to scoop up objects with a clamshell are performed, in a condition where the mode selector switch is set to the "lowering hold releasing mode" or "lowering and rising hold releasing mode", the boom operating lever 16 is manipulated toward the lowering side. The boom 5 moves down until the front end portion of the clamshell is brought into contact with the objects due to the empty weight of the front attachment 4 and when the front end portion of the clamshell is brought into contact with the objects, the boom 5 automatically stops moving down.

[0049] According to the embodiment carried out in such a manner, by selecting a mode using the mode selector switch 23, it becomes possible to move the boom 5 downward with the empty weight or upward with the external force applied to the boom 5. When stones are crushed by the breaker 8, rocks are removed by the bucket 7 on flat ground, or objects are scooped by the

clamshell, the boom 5 can be easily operated and operability is improved. In addition, in this case, a pressure oil is not supplied from the hydraulic pump 11 to the boom cylinder 10, thus contributing to a reduction in fuel consumption.

[0050] Further herein, the downward movement due to the empty weight of the boom 5 is allowed only when the mode selector switch 23 is set to the "lowering hold releasing mode" or "lowering and rising hold releasing mode" and the boom operating lever 16 is manipulated toward the lowering side, therefore there is an advantage in that an inconvenience such that the boom 5 unexpectedly moves down due to the empty weight against the operator's intentions is avoidable.

Industrial Applicability

[0051] According to the present invention, by constructing as such, when the lower side oil discharging passage of a working machine such as a hydraulic shovel is opened, an oil discharge from the head side oil chamber of the boom cylinder is allowed and the boom moves down due to the empty weight. For example, when stone crushing operations are performed by means of a breaker, there is an industrial applicability in that boom operations become easy and fuel consumption can be reduced.

Claims

1. A boom cylinder control circuit of a working machine having a boom cylinder for moving a boom up and down, said control circuit of the boom cylinder comprising;

   a control valve which performs pressure oil supplying and discharging control with respect to the boom cylinder based on manipulations of an operating member;
   a lowering side oil discharging passage which allows oil of a boom cylinder head side oil chamber to flow toward the oil reservoir side without passing through the control valve; and
   a control means which performs opening and closing control of the lowering side oil discharging passage.

2. A boom cylinder control circuit of a working machine as set forth in Claim 1, wherein
   the control circuit of the boom cylinder is further provided with:

   a rising side oil discharging passage which allows oil of a boom cylinder rod side oil chamber to flow toward the oil reservoir side without passing through the control valve and
   a control means for performing opening and closing control of the rising side oil discharging passage.

3. A boom cylinder control circuit of a working machine as set forth in Claims 1 through 2, wherein
   the lowering side oil discharging passage is controlled so as to be opened based on a manipulation of the operating member toward the boom lowering side and on the other hand, when the said lowering side oil discharging passage is open, the lowering side oil discharging passage is controlled so that, even by operating the operating member toward the boom lowering side, the pressure oil is not supplied from the control valve to the boom cylinder.

4. A boom cylinder control circuit of a working machine as set forth in Claims 1 through 3, wherein
   the control means which perform opening and closing control of the lowering side oil discharging passage and the rising side oil discharging passage comprise
   solenoid valves which can be switched between the opening position to open the oil discharging passage and closing position to close the oil discharging passage.

5. A boom cylinder control circuit of a working machine as set forth in Claims 1 through 4, wherein
   the control circuit of the boom cylinder is provided with:

   valves for preventing empty weight-lowering which, when the operating member is not manipulated toward the boom lowering side, prevent oil from being discharged from the boom cylinder head side oil chamber, but, based on a manipulation toward the boom lowering side, allow oil to be discharged from the head side oil chamber.

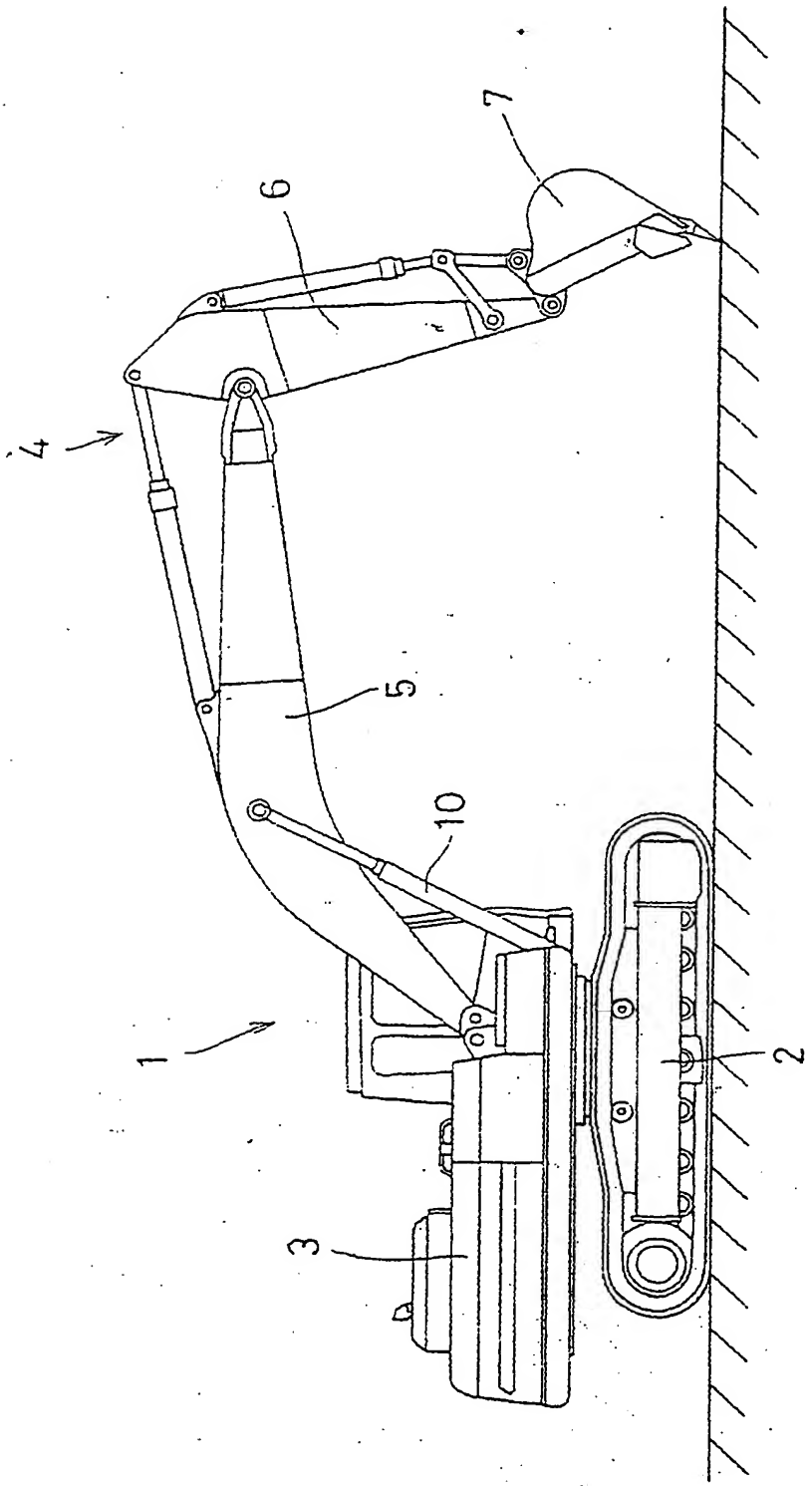

Fig. 1

Fig. 2

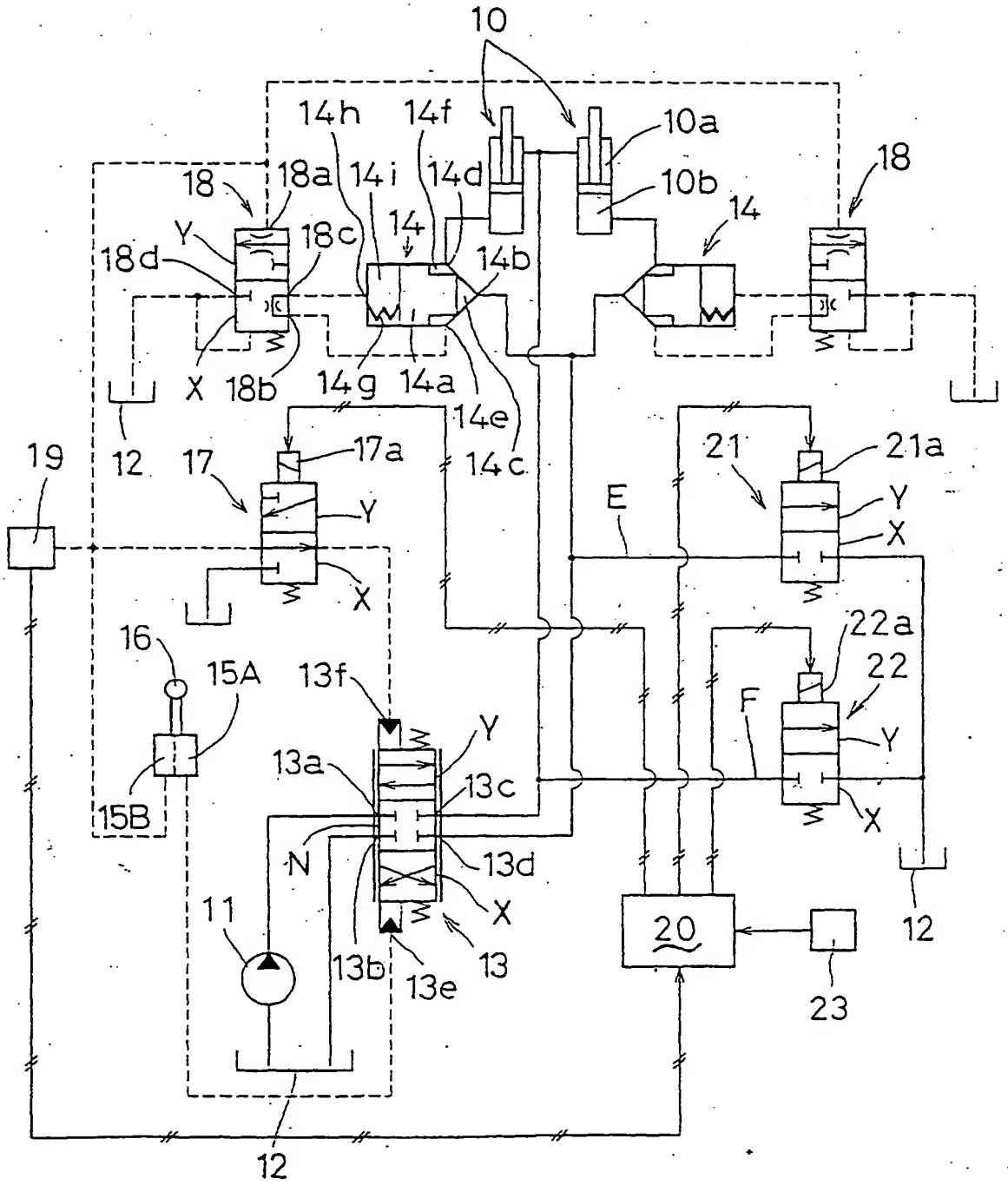
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Fig. 3

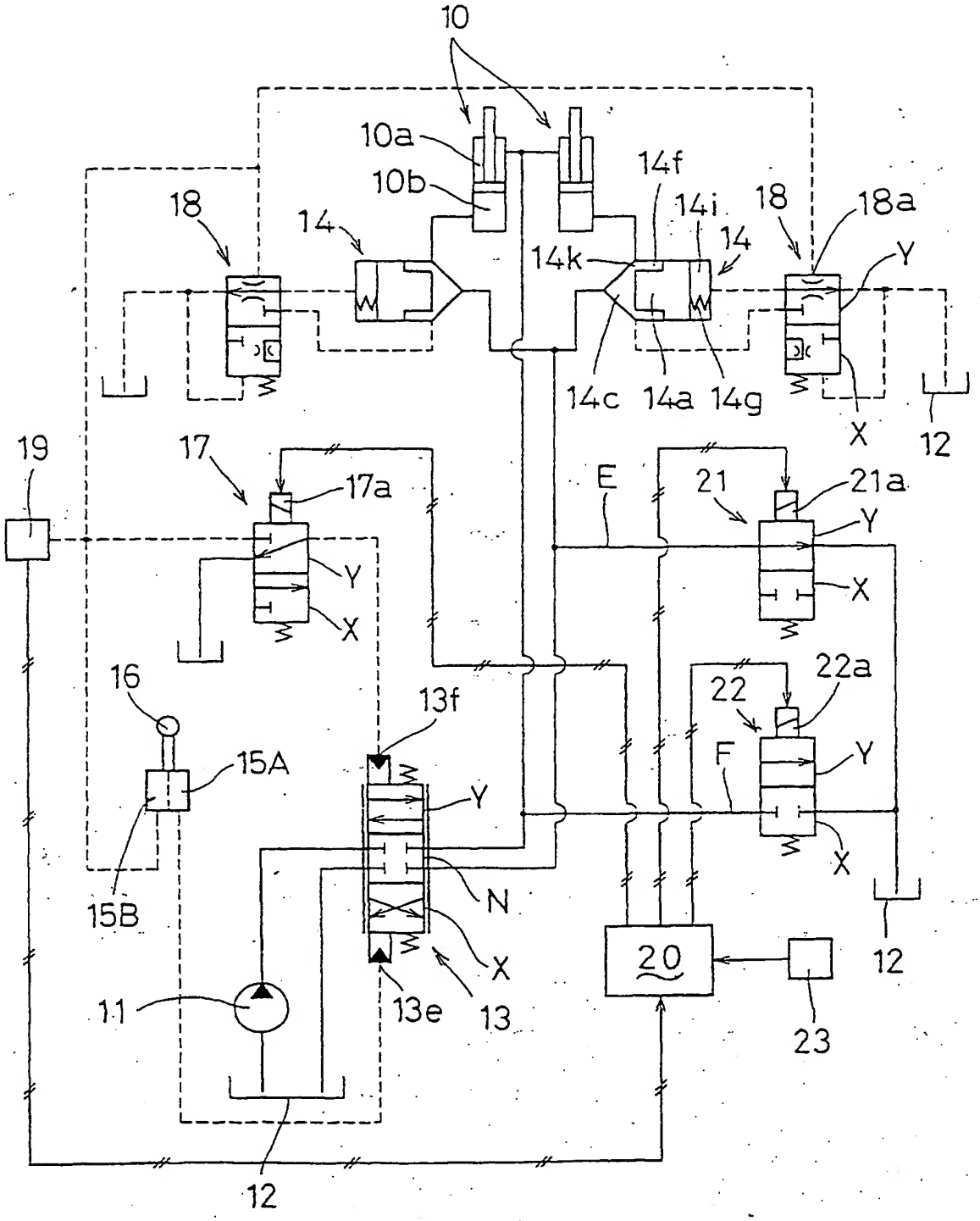
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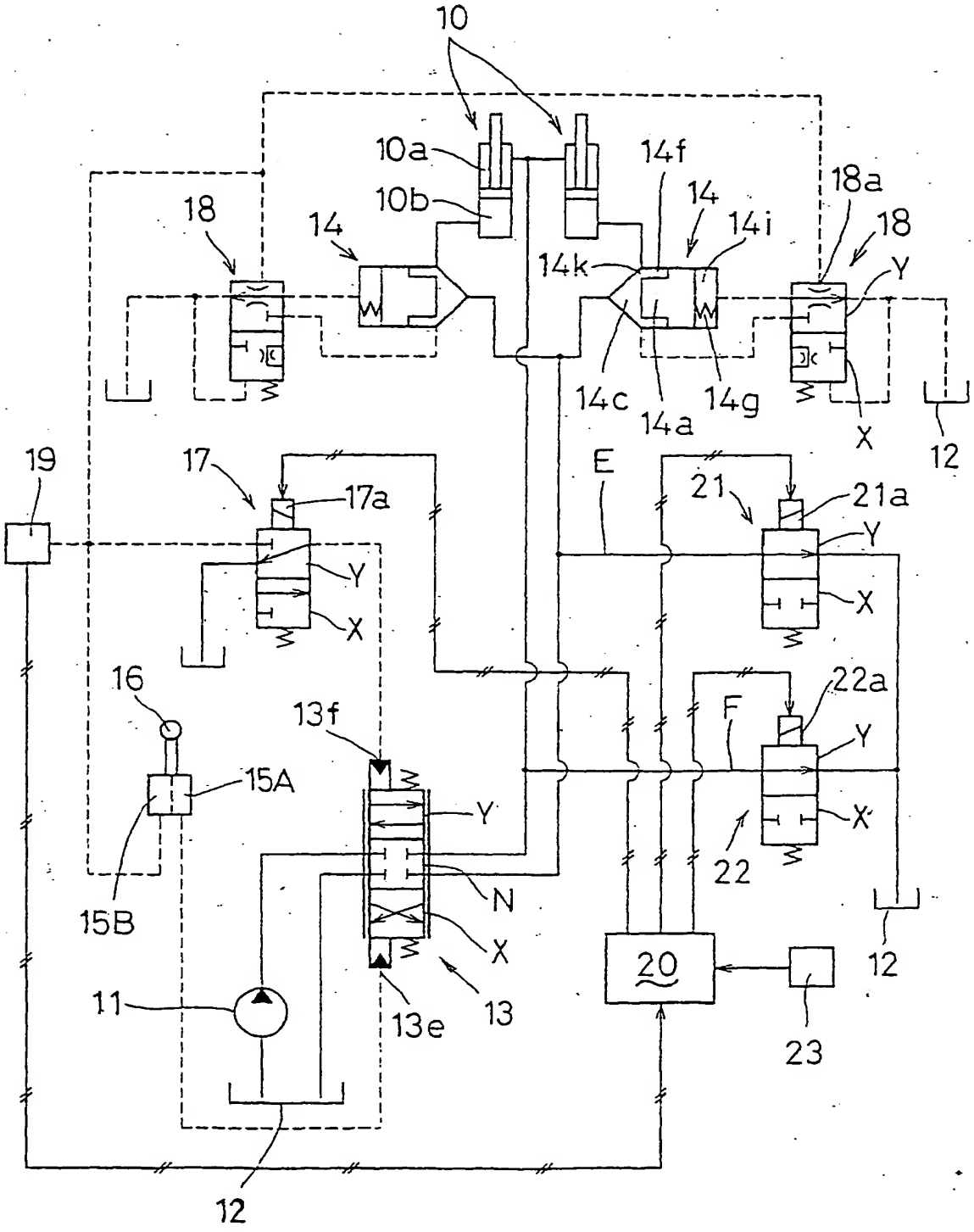
Fig. 4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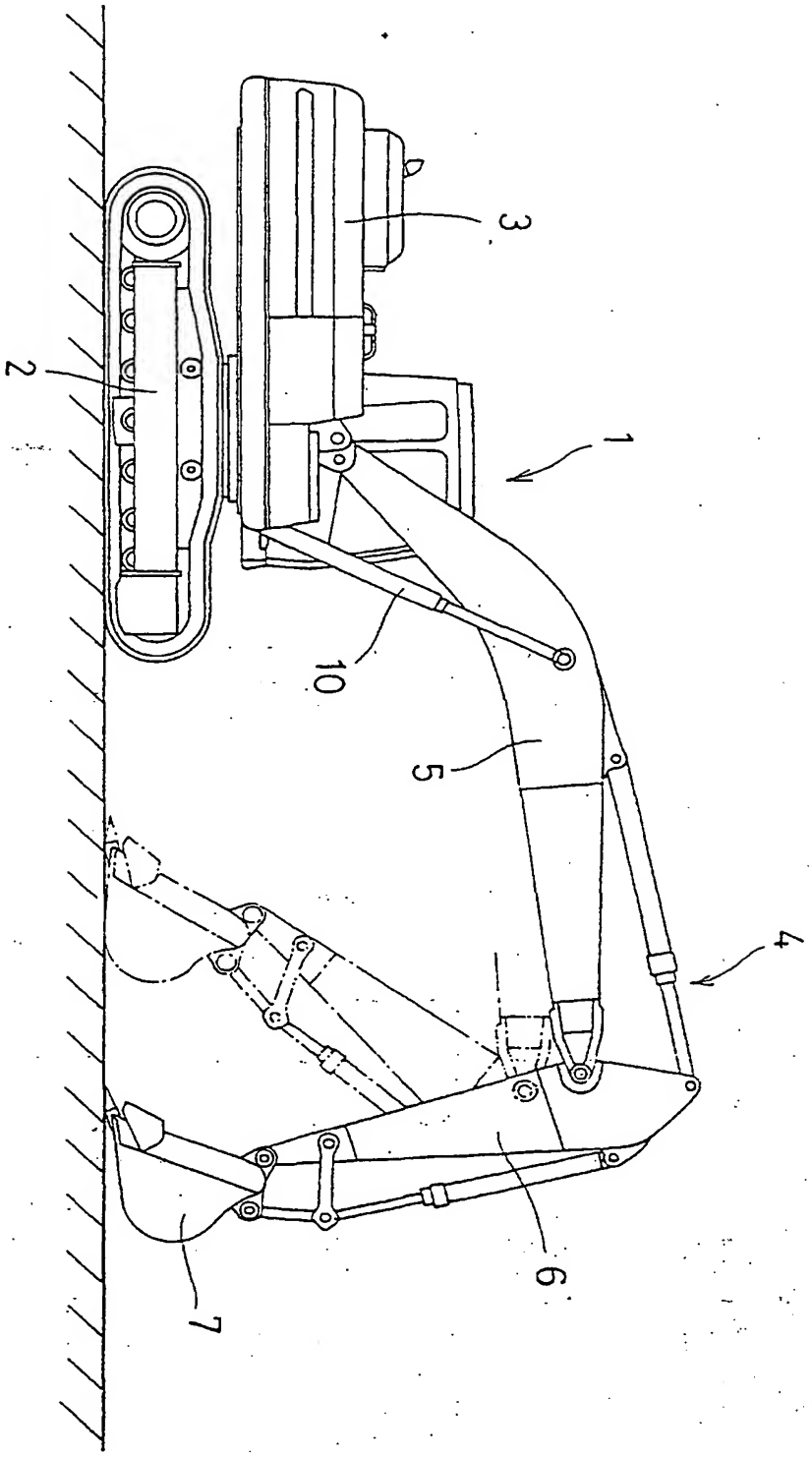

Fig. 5

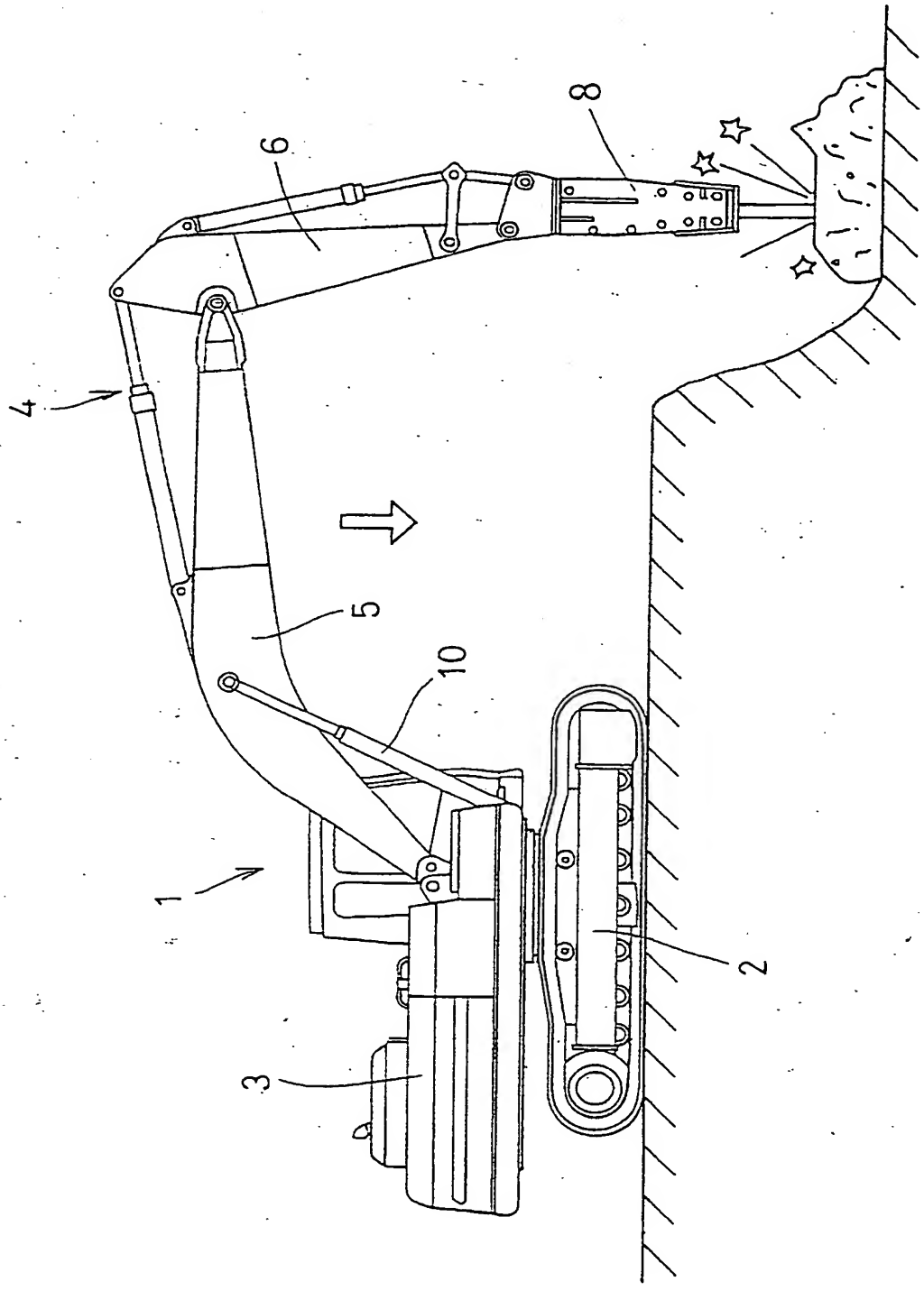

Fig.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/06005

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] E02F9/22, F15B11/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] E02F9/22, F15B11/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2000
Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	JP, 11-158859, A (Koberco Constr. Mach. Eng. Co., Ltd.), 15 June, 1999 (15.06.99),	
X	Par. Nos. [0008]-[0016]; Fig. 3	1,2,4
Y	Par. Nos. [0008]-[0016]; Fig. 3 (Family: none)	3,5
	JP, 9-132927, A (Komatsu Ltd.), 20 May, 1997 (20.05.97),	
X	Par. Nos. [0022]-[0036]; Fig. 2	1
Y	Par. Nos. [0022]-[0036]; Fig. 2	3
A	Par. Nos. [0022]-[0036]; Fig. 2 (Family: none)	2,4,5
	JP, 10-18358, A (Shin Caterpillar Mitsubishi Ltd.), 20 January, 1998 (20.01.98),	
Y	Par. Nos. [0005]-[0015]; Fig. 1	5
A	Par. Nos. [0005]-[0015]; Fig. 1 (Family: none)	1-4

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 November, 2000 (16.11.00)	05 December, 2000 (05.12.00)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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